CLAIMS

What is claimed is:

1. A method of processing a set of GNSS signal data derived from signals having at least three carriers, comprising:
    a. Applying to the set of GNSS signal data a geometry filter using a geometry carrier-phase combination to obtain an array of ambiguity estimates for the geometry carrier-phase combination and associated statistical information;
    b. Applying to the set of GNSS signal data a bank of ionosphere filters using a geometry-free ionosphere carrier-phase combination to obtain an array of ambiguity estimates for the ionosphere carrier-phase combination and associated statistical information;
    c. Applying to the set of GNSS signal data at least one bank of Quintessence filters using a geometry-free and ionosphere-free carrier-phase combination to obtain an array of ambiguity estimates for the geometry-free and ionosphere-free carrier-phase combination and associated statistical information;
    d. Applying to the set of GNSS signal data at least one code filter using a plurality of geometry-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information; and
    e. Combining the arrays of a., b., c. and d. to obtain a combined array of ambiguity estimates for all carrier phase observations and associated statistical information.
2. The method of claim 1, further comprising computing a user position from the combined array.
3. The method of claim 2, wherein the set of GNSS signal data comprises GNSS signal data of a single epoch.
4. The method of claim 1, further comprising computing a user position from the combined array with a combination of float ambiguities and fixed ambiguities by applying an integer-least-squares procedure and a validation procedure.
5. The method of claim 4, wherein the set of GNSS signal data comprises GNSS signal data of a single epoch.
6. The method of claim 1, further comprising computing a user position from the combined array with float ambiguities, and computing a user position from the combined array with a combination of float ambiguities and fixed ambiguities by applying an integer-least-squares procedure and a validation procedure.
7. The method of claim 6, wherein the set of GNSS signal data comprises GNSS signal data of a single epoch.

8. The method of claim 1, wherein applying to the set of GNSS signal data at least one code filter comprises applying to the set of GNSS signal data at least one code filter using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

9. The method of claim 1, wherein applying to the set of GNSS signal data at least one code filter comprises applying to the set of GNSS signal data one code filter for each carrier using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

10. The method of claim 9, wherein the code filters are mutually orthogonal.

11. The method of claim 1, wherein the set of GNSS signal data is derived from signals received from transmitters of a first navigation system, the method further comprising processing a second set of GNSS signal data derived from signals having at least two carriers and received from transmitters of a second navigation system by:

    h. Applying to the second set of GNSS signal data a geometry filter using a geometry carrier-phase combination to obtain an array of ambiguity estimates for the geometry carrier phase combination and associated statistical information;
    i. Applying to the second set of GNSS signal data a bank of ionosphere filters using a geometry-free ionosphere carrier-phase combination to obtain an array of ambiguity estimates for the ionosphere carrier-phase combination and associated statistical information;
    j. Applying to the second set of GNSS signal data at least one bank of Quintessence filters using a geometry-free carrier phase combination to obtain an array of ambiguity estimates for said carrier phase combination and associated statistical information;
    k. Applying to the second set of GNSS signal data at least one code filter using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information; and

    wherein d. further comprises combining the arrays of f., g., h. and i. with the arrays of a., b., c. and d. to obtain a combined array of ambiguity estimates for all carrier phase observations and associated statistical information.

12. The method of claim 11, wherein a. and f. are carried out by applying the first-mentioned set of GNSS signal data and the second set of GNSS signal data to a single geometry filter to obtain a single array of ambiguity estimates for the geometry carrier-phase combination and associated statistical information.

13. The method of claim 11, wherein the first navigation system has a first number of carrier frequencies and observables and the second navigation system has a second number of carrier

frequencies and observables which differs from the first number of carrier frequencies and observables.

14. The method of claim 11, wherein applying to the second set of GNSS signal data at least one code filter comprises applying to the second set of GNSS signal data at least one code filter using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information.
15. The method of claim 11, wherein applying to the set of GNSS signal data at least one code filter comprises applying to the set of GNSS signal data one code filter for each carrier using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information.
16. The method of claim 15, wherein the code filters of h. are mutually orthogonal.
17. The method of claim 1, wherein the GNSS signal data comprises data collected at a plurality of reference receivers.
18. The method of claim 11, wherein the GNSS signal data comprises data collected at a plurality of reference receivers.
19. The method of claim 1, wherein the GNSS signal data comprises data collected at a plurality of roving receivers.
20. The method of claim 1, wherein the GNSS signal data comprises data collected at a plurality of roving receivers.
21. The method of claim 1, wherein the GNSS signal data comprises data generated from a network of reference stations.
22. The method of claim 21, wherein the data generated from a network of reference stations comprises at least one error model.
23. Apparatus for processing a set of GNSS signal data derived from signals having at least three carriers, comprising:
    f. A geometry filter using a geometry carrier-phase combination to obtain from the set of GNSS signal data an array of ambiguity estimates for the geometry carrier-phase combination and associated statistical information;
    g. A bank of ionosphere filters using a geometry-free ionosphere carrier-phase combination to obtain from the set of GNSS signal data an array of ambiguity estimates for the ionosphere carrier-phase combination and associated statistical information;
    h. At least one bank of Quintessence filters using a geometry-free and ionosphere-free carrier-phase combination to obtain from the set of GNSS signal data an array of ambiguity estimates for the geometry-free and ionosphere-free carrier-phase combination and associated statistical information;

i. At least one code filter using a plurality of geometry-free code-carrier combinations to obtain from the set of GNSS data an array of ambiguity estimates for the code-carrier combinations and associated statistical information; and

j. A combiner to produce from the arrays obtained by the filters of a., b., c. and d. a combined array of ambiguity estimates for all carrier phase observations and associated statistical information.

24. The apparatus of claim 23, further comprising a position-computation element to compute a user position from the combined array.

25. The apparatus of claim 24, wherein the set of GNSS signal data comprises GNSS signal data of a single epoch.

26. The apparatus of claim 23, further comprising a position-computation element to compute a user position from the combined array with a combination of float ambiguities and fixed ambiguities by applying an integer-least-squares procedure and a validation procedure.

27. The apparatus of claim 26, wherein the set of GNSS signal data comprises GNSS signal data of a single epoch.

28. The apparatus of claim 23, further comprising a position-computation element to compute a user position from the combined array with float ambiguities, and computing a user position from the combined array with a combination of float ambiguities and fixed ambiguities by applying an integer-least-squares procedure and a validation procedure.

29. The apparatus of claim 28, wherein the set of GNSS signal data comprises GNSS signal data of a single epoch.

30. The apparatus of claim 23, wherein said at least one code filter uses a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

31. The apparatus of claim 23, wherein said at least one code filter uses a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

32. The apparatus of claim 31, wherein the code filters are mutually orthogonal.

33. The apparatus of claim 23, wherein the set of GNSS signal data is derived from signals received from transmitters of a first navigation system, the apparatus further comprising the following elements for processing a second set of GNSS signal data derived from signals having at least two carriers and received from transmitters of a second navigation system:

g. A geometry filter using a geometry carrier-phase combination to obtain from the second set of GNSS signal data an array of ambiguity estimates for the geometry carrier phase combination and associated statistical information;

h. A bank of ionosphere filters using a geometry-free ionosphere carrier-phase combination to obtain from the second set of GNSS signal data an array of ambiguity

estimates for the ionosphere carrier-phase combination and associated statistical information;

i. At least one bank of Quintessence filters using a geometry-free carrier phase combination to obtain from the second set of GNSS signal data an array of ambiguity estimates for said carrier phase combination and associated statistical information;

j. At least one code filter using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain from the second set of GNSS signal data an array of ambiguity estimates for the code-carrier combinations and associated statistical information; and

wherein said combiner produces from the arrays obtained by the filters of e., f., g. and h. and the arrays obtained by the filters of a., b., and c. a combined array of ambiguity estimates for all carrier phase observations and associated statistical information.

34. The apparatus of claim 23, wherein the set of GNSS signal data is derived from signals received from transmitters of a first navigation system, the apparatus further comprising the following elements for processing a second set of GNSS signal data derived from signals having at least two carriers and received from transmitters of a second navigation system:

g. A bank of ionosphere filters using a geometry-free ionosphere carrier-phase combination to obtain from the second set of GNSS signal data an array of ambiguity estimates for the ionosphere carrier-phase combination and associated statistical information;

i. At least one bank of Quintessence filters using a geometry-free carrier phase combination to obtain from the second set of GNSS signal data an array of ambiguity estimates for said carrier phase combination and associated statistical information;

j. At least one code filter using a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain from the second set of GNSS signal data an array of ambiguity estimates for the code-carrier combinations and associated statistical information; and

wherein the geometry filter uses a geometry carrier-phase combination to obtain from the first-mentioned set of GNSS signal data and from the second set of GNSS signal data an array of ambiguity estimates for the geometry carrier phase combination and associated statistical information, and wherein said combiner produces from the arrays obtained by the filters of f., g. and h. and the arrays obtained by the filters of a., b., c. and d. a combined array of ambiguity estimates for all carrier phase observations and associated statistical information.

35. The apparatus of claim 33, wherein the first navigation system has a first number of carrier frequencies and observables and the second navigation system has a second number of carrier

frequencies and observables which differs from the first number of carrier frequencies and observables.

36. The apparatus of claim 33, wherein said at least one code filter of h. uses a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain from the second set of GNSS signal data an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

37. The apparatus of claim 33, wherein said at least one code filter of h. uses a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain from the second set of GNSS signal data an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

38. The apparatus of claim 37, wherein the code filters of h. are mutually orthogonal.

39. The apparatus of claim 34, wherein the first navigation system has a first number of carrier frequencies and observables and the second navigation system has a second number of carrier frequencies and observables which differs from the first number of carrier frequencies and observables.

40. The apparatus of claim 34, wherein said at least one code filter of h. uses a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain from the second set of GNSS signal data an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

41. The apparatus of claim 34, wherein said at least one code filter of h. uses a plurality of geometry-free and ionosphere-free code-carrier combinations to obtain from the second set of GNSS signal data an array of ambiguity estimates for the code-carrier combinations and associated statistical information.

42. The apparatus of claim 41, wherein the code filters of h. are mutually orthogonal.

43. The apparatus of claim 23, wherein the GNSS signal data comprises data collected at a plurality of reference receivers.

44. The apparatus of claim 33, wherein the GNSS signal data comprises data collected at a plurality of reference receivers.

45. The apparatus of claim 34, wherein the GNSS signal data comprises data collected at a plurality of reference receivers.

46. The apparatus of claim 23, wherein the GNSS signal data comprises data collected at a plurality of roving receivers.

47. The apparatus of claim 23, wherein the GNSS signal data comprises data collected at a plurality of roving receivers.

48. The apparatus of claim 23, wherein the GNSS signal data comprises data generated from a network of reference stations.

49. The apparatus of claim 48, wherein the data generated from a network of reference stations comprises at least one error model.